Montana Department of
ENVIRONMENTAL QUALITY

Water Quality Assessment Method

June 20, 2011

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WQPBWQM-001

Suggested citation: Department of Environmental Quality, Water Quality Planning Bureau. 2011. Water Quality Assessment Method. Helena, MT: Montana Dept. of Environmental Quality.

REVISION HISTORY

Revision No.	Date	Modified By	Sections Modified	Description of Changes
3.0	June 2011	M. McCarthy	All	Major revision to provide a structured and consistent approach for assessing Montana's waters. The most significant changes to the process are the incorporation of pollutant-specific methods to assess water quality and a specific process for evaluating data used for assessments.

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ACRONYMS

Acronym	Definition
AFDW	Ash Free Dry Weight
ARM	Administrative Rules of Montana
AU	Assessment Unit
BOD	Biochemical Oxygen Demand
CFL	Cycle First Listed
CFR	Code of Federal Regulations
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DO	Dissolved Oxygen
DQA	Data Quality Assessment
EPA	Environmental Protection Agency (US)
HBI	Hilsenhoff Biotic Index
MCA	Montana Code Annotated
MWQA	Montana Water Quality Act
NHD	National Hydrography Data(set)
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Residual Pool Depth
RSI	Riffle Stability Index
SAP	Sampling and Analysis Plan
SCD	Sufficient Credible Data
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
USGS	United States Geological Survey
WARD	Water quality Assessment, Reporting, and Documentation system
WQS	Water Quality Standards

EXECUTIVE SUMMARY

This update of the Montana Department of Environmental Quality's (DEQ) Water Quality Assessment Method includes a substantial change in the process. The ultimate goal is to provide a structured and consistent approach for assessing Montana's waters. DEQ's assessment method is built to the goals and concepts of Montana's Water Quality Act and better aligns the assessment process with the water quality goals expressed in Montana's water quality standards.

At present, DEQ has developed assessment methods for nutrients, sediment, metals, and temperature pollutant groups, which represent the most common pollutants impairing Montana's surface waters. Each pollutant method provides for sound and consistent water quality assessments, which will allow DEQ to make reproducible and defensible decisions about beneficial-use support.

This new method differs from the Water Quality Assessment Process and Method that was used in previous listing cycles and includes two significant changes: (1) the incorporation of pollutant-specific methods to assess water quality; (2) a specific process for evaluating data used for assessments.

Under the new assessment method, determinations of beneficial-use support are specific to the pollutant groups. Each pollutant group has specific core indicators that have spatial and temporal requirements, defined index periods, and a minimum sample size. Each pollutant-specific method has a clear decision framework and uses statistical analysis for making decisions of beneficial use support or non-support.

The nutrient, sediment, and temperature methods have two levels of assessment. Core indicators are collected in the first level of assessment to evaluate whether water quality standards have been met or not. When clear decisions cannot be made, a level II assessment is performed. This often requires another year of data collection and may require supplemental indicators to help support the decisions.

Previous versions of the state's assessment method (for the period 2000–2008) used a process called Sufficient Credible Data (SCD) to determine the validity and reliability of data used in assessments. SCD considered the technical, representative, currency, quality, and spatial and temporal components of readily available data and information for each data type (biological, chemical, and physical/habitat). It also established a measure of rigor for each data type. The sum of all data types were then translated into a qualitative statement of confidence for the beneficial-use assessment.

The new pollutant-based assessment method also has specific objectives and decision-making criteria for determining the validity and reliability of data used in making assessments. Rather than using SCD, the new method uses a process called Data Quality Assessment (DQA). DQA considers most of the same technical, spatial, temporal, quality, and age components as the SCD process; however, a DQA is conducted individually per beneficial use and pollutant group (e.g., aquatic life – nutrients). Further, this process considers Montana's large size, the number of waterbodies within the state's jurisdiction, current water quality management goals, and limited resources for monitoring.

Montana's new Water Quality Assessment Method will provide a consistent process that the entire water quality management program can use—each for its specific program need—when evaluating water quality. The new method also provides DEQ with a transparent and repeatable process for making use-support decisions and, moreover, it will improve the level of certainty in assessment decisions.

1.0 INTRODUCTION

The Montana Department of Environmental Quality (DEQ) is the state agency responsible for implementing components of the Montana Water Quality Act (MWQA). The MWQA reflects the federal Water Pollution Control Act, commonly referred to as the "Clean Water Act" (CWA), for waters under state jurisdiction. DEQ assesses water quality based on established standards, using available data, and reports its findings on the status and trends of water quality in Montana's biennial Integrated Report.

This document describes the assessment methods DEQ uses to make decisions about beneficial-use support (i.e., whether surface water quality standards have been met). Additionally, this document describes for the public how assessment decisions about water quality are made.

This new method differs from the Water Quality Assessment Process and Method that was used in previous listing cycles and includes two significant changes: (1) the incorporation of pollutant-specific methods to assess water quality; (2) a specific process for evaluating data used for assessments.

1.1 METHODS OVERVIEW

At present, DEQ has developed individual assessment methods for nutrients, sediment, metals, and temperature pollutant groups, which represent the most common pollutants impairing Montana's surface waters. The assessment method for each pollutant group is based on the best available science and techniques for making consistent use-support decisions. DEQ recognizes that each method may be adjusted, or new methods may be developed, as more tools and information become available and as science improves. Additional methods will be phased in over time as they are developed. In addition, DEQ will establish a general process as needed that will apply to other pollutants (i.e., E. Coli, pesticides, organics) numeric standards.

DEQ's use-support decisions to list or not list a waterbody are based on the frameworks provided in this Assessment Method document. These decisions are based on scientifically valid and representative data that meet the requirements specified in this document. The methods provide continuity and consistency for assessors to make sound decisions, which in turn will allow DEQ to make reproducible and defensible listing decisions.

Each method requires collecting specific data. A standard protocol allows data sets to be compared. In addition, each method has specific requirements for assessing data quality in order to determine that data's validity and reliability. Each method also has rules for making decisions about use support or non-support.

1.2 EVALUATION OVERVIEW

In order to make decisions about whether a waterbody supports its beneficial uses, the assessment methods include two basic levels of rigor for evaluating data. In the first level of assessment core indicators are collected to evaluate support of beneficial use. In some cases, clear decisions cannot be made, requiring a second level of assessment. During a Level II assessment additional data (more core indicators) are collected, along with supplemental indicators, if available, to help make a decision.

For example, for evaluating use support for aquatic life, both the nutrients and sediment methods consider how different data types relate. To the degree practicable, they also consider all applicable data and information. Chemical or physical core indicator data can be considered together with biological core indicator data to determine use support or non-support. Greater weight is given to the core indicators that provide direct indication of impairment, and individual decisions are made by applying both narrative and numeric criteria for the data. When the data types agree in Level I assessments, use-support determinations can be made. When measures do not agree, a Level II assessment is required. If conclusions remain unclear after a Level II assessment, best professional judgment is applied, and management is consulted to determine an outcome; the methods clearly describe the cases in which this should occur.

Because a one-size-fits-all monitoring program—which would apply a broad suite of parameters to every waterbody—is resource intensive, DEQ currently uses a pragmatic, focused approach to monitoring. In order to make the right water quality use-support decisions, DEQ is moving toward risk-based assessments that align with EPA's Watershed Risk Assessment ideas. This version of the assessment method is deliberately focused on the most prevailing causes of impairment. DEQ will monitor and assess for the parameter group(s) identified as likely to cause impairment for that waterbody. Although DEQ is focusing on the four pollutant-specific assessments described in this document, other pollutants and pollution will be considered when there is an identified risk. This will be addressed when planning and developing the monitoring design.

2.0 WATER QUALITY STANDARDS

Water quality standards define the water quality goals of a waterbody by designating the uses it is expected to support. Standards set the criteria that define the water quality necessary to protect the designated uses and prevent degradation through nondegradation provisions. Thus, water quality standards are a triad comprising beneficial uses, criteria, and nondegradation. States adopt water quality standards to protect beneficial uses, enhance the quality of water, and meet MWQA requirements. This assessment methodology is consistent with Montana's water quality standards and forms the basis for assessing water quality conditions.

2.1 BENEFICIAL USES

Montana classifies its waterbodies according to the present and future beneficial uses they should be capable of supporting. Beneficial uses are the valuable characteristics of surface water that, directly or indirectly, contribute to human welfare. The surface water quality standards and procedures, located in the Administrative Rules of Montana (ARM) Subchapter 6, begin with a policy statement identifying the general beneficial uses of Montana's waters:

ARM 17.30.601 – POLICY

> *(1) The following standards are adopted to conserve water by protecting, maintaining, and improving the quality and potability of water for public water supplies, wildlife, fish and aquatic life, agriculture, industry, recreation, and other beneficial uses.*

For the purposes of this assessment method, the beneficial uses to be evaluated are summarized into the following categories: drinking water, aquatic life (coldwater or warmwater fish), recreation, and agriculture.

In ARM, the beneficial uses are further grouped into classes (e.g., A-closed, A-1, B-1, B-2, etc.) based on ecological factors related to the waterbody's location and potential to support its uses[1]. These classes are primarily based on water temperature, the fish and associated aquatic life expected to be found, and the treatment required for potable water. **Table 1-1** describes the beneficial uses expressed per use class.

Table 1-1. Beneficial Uses Described in Use Classification

Beneficial Uses	Use Classification							
	A Closed	A-1	B-1	B-2	B-3	C-1	C-2	C-3
Drinking, culinary, and food processing (simple disinfection)	X							
Drinking, culinary, and food processing (conventional treatment of naturally present impurities)		X						
Drinking, culinary, and food processing (conventional treatment)			X	X	X			M
Fishes (salmonid) & assoc. aquatic life (growth)	X[2]	X	X	X		X	X	
Fishes (salmonid) & assoc. aquatic life (propagation)		X	X	M		X	M	
Fishes (non-salmonid) & assoc. aquatic life (growth)					X			X
Fishes (non-salmonid) & assoc. aquatic life (propagation)					X			X
Bathing, swimming, recreation (plus aesthetics via gen. prohib.)	X	X	X	X	X	X	X	X
Agriculture water supply		X	X	X	X	X	X	M
Industrial water supply		X	X	X	X	X	X	M

X = Beneficial Use
M = Marginal Use

A waterbody supports its beneficial uses when it meets the water quality standards (WQS) established to protect those uses. A waterbody is impaired when any one of its WQS is not met. Determining whether a specific use is supported is independent of all other beneficial uses for that same waterbody. For example, a waterbody may not support aquatic life and primary recreations because of excess nutrients, but support drinking water and agriculture uses. In addition, under rulemaking by the Montana Board of Environmental Review and subsequent approval by EPA, beneficial uses cannot be removed from a waterbody without carrying out a formal use-attainability analysis. The current assessment methods allow DEQ to determine whether each waterbody fully supports each of its beneficial uses regarding specific pollutants. In future revisions of the assessment method DEQ will address how to apply the "threatened" status.

2.2 WATER QUALITY CRITERIA

The second major component of water quality standards is the criteria used to protect the beneficial uses of all surface waters. Water quality criteria can be expressed in either numeric or narrative form.

[1] ARM 17.30.621- 629 and 17.30.650-658
[2] The A-Closed class does not distinguish between salmonid and non-salmonid fishes.

NOTE: In Montana, common usage of the word "standards" is often applied to both numeric and narrative criteria. Waters must protect the most sensitive use; therefore, when more than one use is associated with a pollutant group, the most stringent criteria should be used to assess beneficial use support.

2.2.1 Numeric Criteria

Criteria expressed as constituent concentrations, or levels, are commonly referred to as numeric criteria. States may adopt numeric criteria based upon EPA's CWA 304(a) guidance values or develop state- or site-specific criteria, per CWA 303(c). In either case, numeric criteria (1) are use specific, (2) must be based on sound scientific rationale, and (3) must contain sufficient constituents, or parameters, to protect the beneficial use.

Montana has established numeric criteria for:

- chronic and acute levels of constituents affecting fishes and associated aquatic life (Circular DEQ-7)
- human health risks from constituents through drinking, culinary, and food processing uses (Circular DEQ-7)
- human health risks from *Escherichia coli* levels via recreation in and on the water (ARM 17.30.620-629)
- aesthetic qualities from excess algal biomass and nutrient levels in the Clark Fork River (ARM 17.30.631)
- risks to agriculture from excessive dissolved salts—expressed as electrical conductivity and sodium absorption ratio—in the Powder, Tongue, Rosebud, and Little Powder rivers (ARM 17.30.670)

Numeric criteria are more than simple expressions of the allowable concentration (i.e., magnitude) of a pollutant; aquatic life criteria also take into consideration the duration of exposure to the pollutant (averaging period) and frequency (how often the criteria can be exceeded). Acute criteria are based on a 1-hour exposure event and can be exceeded only once, on average, in a 3-year period. Chronic criteria are based on a 96-hour exposure and can be exceeded only once, on average, in a 3-year period. Human health standards have a frequency and duration of zero and are expressed as "may not exceed." Magnitude, duration, and frequency combined provide the context for applying numeric criteria in use-support decision-making.

2.2.2 Narrative Criteria

Narrative criteria are expressed as statements of the desired water quality goal. Unlike numeric criteria, they are qualitative descriptions without definitive expressions of magnitude, duration, or frequency. Narrative criteria are used for pollutants for which numeric criteria are difficult to specify, such as color and odor, or where natural occurrence and variability would make definitive numerical limits overly complex, such as with sediment. Instead, narrative criteria rely upon an understanding of what constitutes harm to the uses they are intended to protect. Uses must be considered individually. Harm-to-use determinations may rely upon more generalized criteria to interpret harmful conditions, or upon best professional judgment.

Natural or Naturally Occurring

Some of Montana's water quality standards are defined as a relative change from what would naturally exist, such as "no increases are allowed above naturally occurring condition" or "no change from

natural". Because all of our criteria are prefaced with "no person may," DEQ will make assessment decisions only when human-caused sources are identified. If no human-caused sources are found, DEQ will make no beneficial use support decisions.

2.3 NONDEGRADATION

The final component of a state's water quality standards is the nondegradation provision, which is used in conjunction with other elements of water quality standards to form a comprehensive approach to protect and enhance water quality. Montana nondegradation provisions maintain and protect existing water quality conditions. In essence, the nondegradation provisions are intended to protect surface waters whose quality is currently superior to the water quality criteria. In Montana, nondegradation is applied using a pollutant-specific approach as they affect the individual uses that are fully supported. For example, when a waterbody is impaired for nutrients, it is not supporting all of its applicable beneficial uses. The goal is to maintain the other uses that are supported by the existing water quality.

The Administrative Rules of Montana describe the requirements for what constitutes non-significant degradation and the conditions under which authorizations to degrade (e.g., discharge permits) are allowed (ARM 17.30.701–718).

3.0 IDENTIFYING AVAILABLE WATER QUALITY DATA

DEQ is required by state and federal law to assemble and evaluate all existing and readily available data and information for assessing surface water quality in Montana. DEQ must ensure that the data used for assessments are valid and reliable. Data submitted from outside sources must be defensible and the quality of that data known before being considered for assessments.

In preparation of the state's water quality Integrated Report, DEQ solicits outside data and information from other local, state, and federal agencies; volunteer monitoring groups; private entities; nonprofit organizations; and individuals involved in water quality monitoring and management. The data and information obtained from outside sources are combined with the results of DEQ's ongoing monitoring efforts to provide the basis for water quality assessments. Minimum data requirements have been established and are published in Montana's call for existing and readily available data. DEQ may decide not to use particular data or information that does not meet data quality requirements.

DEQ will review chemical, biological, and physical/habitat data to determine if its rigor is adequate for use in decision-making. In addition, to be useful for assessing the waterbody, data must be representative of the ambient water quality conditions. If data are of sufficient quality, they are incorporated into the water quality assessments.

3.1 MINIMUM DATA REQUIREMENTS

In order for DEQ to use data for decision-making, the data must be of documented quality and must include the minimum requirements listed below (this also applies to data submitted by outside sources). Data that does not meet DEQ quality objectives will not be included formally in the assessment but may be used to supplement the assessment determination.

- Data must be <10 years old. Data >10 years old may be used for historical reference only.
- Data must include written documentation, such as a Quality Assurance Project Plan (QAPP) and/or Sampling and Analysis Plan (SAP) that clearly describes the following:
  - monitoring objective
  - data quality objectives
  - study design, including the rationale for the selection of sampling sites, water quality parameters, and sampling frequency, as well as the project controls that assured the actual sampling met the intended design
  - field and laboratory sample collection and analytical methods
  - Quality Assurance/Quality Control (QA/QC) requirements
  - data analysis, including the verification and validation processes
- Data must include written assurance or QA/QC documentation demonstrating that procedures and methods in the QAPP and SAP were followed to support reproducible results and meet data requirements.
- Data must include field notes, laboratory notations, or summaries that indicate deviations from the QAPP or SAP and their potential impact on the data quality and objective outcome.
- Data must be linked to a particular site on a particular waterbody and include location information (e.g., latitude/longitude).
- Data must be submitted to DEQ in the specific MT-eWQX format using the data submittal process described in "MT-eWQX Guidance Manual - Call for Data" available at http://deq.mt.gov/wqinfo/datamgmt/MTEWQX.mcpx.

MT-eWQX is DEQ's main repository for storing water quality monitoring data, which includes physical, chemical, biological, and habitat data from a variety of projects across the state.

3.2 DATA QUALITY ASSESSMENTS

The Montana Water Quality Act directs DEQ to "develop and maintain a data management system that can be used to assess the validity and reliability of the data used in the listing and priority ranking process." DEQ's data management system permits the assessor to document all the measures of data rigor. This assessment record allows users to understand an assessor's basis (i.e., level of underlying information) for his/her use-support decisions. Data quality assessments (DQA) are conducted for each waterbody per each beneficial use and pollutant group (e.g., aquatic life – nutrients). Previous versions of the state's assessment method (for the period 2000–2008) used a process called Sufficient Credible Data (SCD) to determine the validity and reliability of data used in assessments.

Data are evaluated for validity and reliability for use in assessment decisions. The DQA reviews physical, chemical, and biological data, as well as information about the technical, spatial/temporal, quality, and age of the data. The process allows DEQ to make decisions for individual beneficial uses when sufficient data is available for specific pollutants identified as likely to impair a particular use. The pollutant-based assessment methods have minimum data requirements, including data independence, which must be met before applying the decision-making criteria.

4.0 ASSESSMENT UNITS

Water quality assessments are made about waterbody segments (stream reaches, lakes, or reservoirs) called Assessment Units (AUs). AUs are delineated using various factors, such as by minimum and

maximum length (streams only); along hydrologic or watershed boundaries; or by use classification, geomorphology, or surrounding land use. AUs are intended to represent relatively homogeneous segments and have endpoint criteria to keep them manageable for reporting.

An AU's geographic location is based on the U.S. Geological Survey's (USGS) high resolution 1:24,0000 National Hydrographic Dataset (NHD). The high resolution NHD provides the best representation of the state's surface waters and is generally equivalent to USGS 1:24,000 topographic maps.

DEQ assigns a unique identification (ID) number to each AU. **Table 4-1** describes the ID naming convention used in AU assessments.

Table 4-1. AU Naming Convention

Example: MT41B001_010 – Beaverhead River, Clark Canyon Dam to Grasshopper Creek		
MT41B	**001**	**010**
Location: This identifier (41B) signifies one of Montana's 86 minor basins.	**Predominance Sequence:** The 3-digit number (001, 002, etc.) begins the predominance sequencing of the waterbodies within the minor basin. Generally, "001" indicates the mainstem river of the minor basin.	**Individual Segments:** The last three digits identify the individual segments occurring within the predominance level.

4.1 MANAGING THE ASSESSMENT RECORD DATA

Detailed records of water quality assessments are maintained in DEQ's Water Quality Assessment, Reporting, and Documentation information management system (WARD). The assessment record includes (a) citations of all underlying data and information used in the assessment, (b) a record of the data quality assessment, (c) a data matrix highlighting key data and information from each citation, (d) summary information on the listing history and overall condition of the waterbody, and (e) specific use support details, including causes and sources of impairment where identified. This information provides the basis for the state's list of impaired waters in need of TMDL development.

5.0 REPORTING THE STATUS OF MONTANA'S WATER QUALITY

Waters under state jurisdiction are assessed to determine whether they support their beneficial uses and meet water quality criteria. As required under the MWQA, DEQ assesses water quality based on established standards, using available data, and reports its findings on the status and trends of water quality. Montana's biennial Integrated Report describes the quality of Montana's waters and provides an overall assessment on the status of water quality conditions in the state and lists the impaired waters not meeting state water quality standards and that require a Total Maximum Daily Load (TMDL). This report also satisfies the requirements of CWA sections 303(d) and 305(b). Per section 305(b), the Integrated Report describes general water quality conditions of the state's water resources. Per section 303(d), the Integrated Report lists waters not meeting state water quality standards and that require a Total Maximum Daily Load (TMDL).

5.1 LISTING CATEGORIES FOR SURFACE WATERS

For the Integrated Report, AUs are assigned to a listing category based on assessment results (**Table 5.1**). There are five core categories; Category 4 has three subcategories. Also, the state has added two user-defined, or custom, categories to Category 2. Categories range from fully supporting all uses (Category 1) to one or more impaired uses, which requires a TMDL (Category 5). Waters in Category 5 represent the state's impaired waters list.

Table 5-1. Integrated Report Listing Categories

Integrated Report Category	Description
Category 1	All applicable beneficial uses have been assessed and all uses are determined to be fully supported.
Category 2	Available data and/or information indicate that some, but not all, of the beneficial uses are supported.
Category 2A[1]	*Available data and/or information indicate that some, but not all, of the beneficial uses are supported* (i.e., all assessed uses are fully supported but not all uses have been assessed).
Category 2B[1]	*Available data and/or information indicate that a water quality standard is exceeded due to an apparent natural source in the absence of any identified anthropogenic (human-caused) sources.*
Category 3	There is insufficient data to assess the use-support of any applicable beneficial use; no use-support determinations have been made.
Category 4A	All TMDLs needed to rectify all identified threats or impairments have been completed and approved (i.e., all necessary TMDLs have been completed).
Category 4B	"Other pollution control requirements required by local, state, or federal authority" [see 40 CFR 130.7(b)(1)(iii)] are in place, are expected to address all waterbody-pollutant combinations, and are expected to attain all WQS in a reasonable period of time. These control requirements act "in lieu of" a TMDL, thus no actual TMDLs are required.
Category 4C	Identified threats or impairments result from pollution categories such as dewatering or habitat modification and, thus, a TMDL is not required (i.e., TMDLs are not required since no pollutant-related use impairment is identified).
Category 5	One or more applicable beneficial uses are impaired or threatened and a TMDL is required to address the factors causing the impairment or threat.

[1]Categories 2A and 2B are user defined.

5.2 CHANGING AU CATEGORIES

A waterbody in a particular AU category may be switched to another AU category during the new reporting cycle if (a) new data or information indicates that the AU should be changed or was improperly assessed or (b) if there are changes to the assessment method, and assessment indicates the AU should be changed to another category.

5.3 DELISTING FROM THE IMPAIRED LIST

The Montana Water Quality Act contemplates that listings may be revised when new monitoring data becomes available (75-5-702(1) MCA.) This is implied to be both new listings and removal of existing listings (delisting). The act is less specific about the delisting mechanism. For consistency and to assure that lists submitted to EPA for approval meet both the needs of the Montana Water Quality Act and federal Clean Water Act, the specific reasons for delisting used in this version of the assessment method

are the "good cause" provisions provided in 40 CFR Part 130.7(b)(6)(iv). Pollutants on water segments may be removed from the impaired waters list if any of the conditions in **Table 5-2** are met.

If all impairments for a water segment are delisted and all beneficial uses attained, the water will be moved to IR Category 1.

Table 5-2. Delisting Process Used by Montana

Delist Reason	Delist Result
New data or information indicates full support of beneficial uses because water quality has been restored and water quality standards are being met.	The waterbody-pollutant combination is moved from Category 5 to Category 1.
Flaws in the original analysis of data and information led to the water being incorrectly listed.	The waterbody-pollutant combination is removed from Category 5, and the AU moves to the listing category as defined by the status of those remaining listings.
Other point source or nonpoint source controls are expected to meet water quality standards.	The waterbody-pollutant combination is moved from Category 5 to Category 4B.
The impairment is due to a non-pollutant.	The waterbody-pollutant combination is moved from Category 5 to Category 4C.
A TMDL was completed and approved by EPA.	The waterbody-pollutant combination is moved from Category 5 to Category 4A.
The waterbody is not in the state's jurisdiction.	The waterbody-pollutant combination is removed from Category 5, and the AU moves to the listing category as defined by the status of those remaining listings.
Other	The waterbody-pollutant combination is removed from Category 5, and the AU moves to the listing category as defined by the status of those remaining listings.

6.0 METHODS FOR ASSESSING POLLUTANT GROUPS

Metals, nutrients, sediment, and temperature will each be evaluated independently in order to determine beneficial-use support. The method for each parameter provides a consistent and defensible approach for assessing whether the pollutant is impairing a waterbody's ability to support its beneficial uses. Based on the decision frameworks provided in this Assessment Method document, DEQ will determine whether to list or not list a waterbody.

Study boundaries or assessment reaches consist of an AU or various reaches of a defined AU. Based on assessment method requirements, the assessor develops a sampling design to define the assessment reach and determine when stratification is warranted. For example, an AU can be stratified when one of its reach's condition differs substantially from other parts of the AU (i.e., it is not homogeneous).

Appendix A includes templates that summarize each assessment method. Each template describes:

- beneficial uses relevant to the pollutant group
- applicable surface waters
- core indicators
- specific data requirements
- requirements for data quality assessment
- decision rules and analytical tools

Appendix B includes listing decision-making matrices for nutrients, sediment, and temperature.

6.1 METALS

Beneficial Uses: Aquatic Life/Fishes & Drinking Water

Applicability: All Montana Surface Waters

Level I Core Indicators: Metals Concentrations

Method Overview: Using numeric WQS for metals, a single-level process determines whether beneficial uses are being supported. The total recoverable fraction is considered for all metals except aluminum (which is analyzed for the dissolved fraction).

For aquatic life/fishes, a Level I assessment evaluates metals concentration data against acute and chronic aquatic life WQS, using a fixed allowable exceedance rate of 10%. If either of the two following conditions are met within the dataset, the waterbody is not attaining water quality standards for a particular metal: (1) aquatic life WQS exceedance rate > 10% or (2) at least 1 sample exceeds twice the acute aquatic life WQS. If the exceedance rate is >10% but no human-caused metals sources are located in the drainage, the assessor should consult management for a case-by-case review.

For drinking water, a Level I assessment evaluates metals concentration data against human health WQS. The waterbody is not attaining water quality standards if at least 1 sample exceeds the human health WQS.

Tables 6-1 and **6-2** show the core indicators used for decision-making.

Table 6-1. Metals Core Indicators (Aquatic Life/Fishes)

	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level I	Metals Concentrations	n ≥ 8 or n = 6 with ≥ 3 exceedances, where necessary	Data (μg/L) are evaluated against aquatic life WQS using allowable exceedance rate (exceedance = 10%)	Year-round (at least 33% of sample set collected during high flow and the rest during baseflow)	≥ 30 days during baseflow; temporal independence is evaluated on a case-by-case basis during high flow and ≥ 1 stream mile

Statistical Analyses:

Methods	Limits on Decision Errors
Percent Exceedance Rate	α and β = approximately 0.35 (35%)

Table 6-2. Metals Core Indicators (Drinking Water)

	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level I	Metals Concentrations	n ≥ 8 or n ≥ 1 with ≥ 1 exceedance, where necessary	Data (μg/L) are evaluated against human health WQS with no allowable exceedances (exceedance = 0%)	Year-round (at least 33% of sample set collected during high flow and the rest during baseflow)	≥ 30 days during baseflow; temporal independence is evaluated on a case-by-case basis during high flow and ≥ 1 stream mile

Statistical Analyses:

Methods	Limits on Decision Errors
Percent Exceedance Rate	Not applicable

6.2 NUTRIENTS – MOUNTAINOUS AND TRANSITIONAL STREAMS

Beneficial Uses: Aquatic Life/Fishes & Primary Contact Recreation

Applicability: All Montana Surface Waters

Level I Core Indicators: Nutrients [Total Nitrogen (TN), Total Phosphorus (TP)], Benthic Algal Chlorophyll *a*/Ash-Free Dry Weight, Diatoms (if available data exists)

Level II Core Indicators: Nutrients (TN, TP), Benthic Algal Chlorophyll *a*/Ash-Free Dry Weight, Diatoms, Macroinvertebrates

Method Overview: Using ecoregion-specific nutrient criteria, a two-level process determines whether beneficial uses are being supported. The Level I assessment considers together the results from two nutrient statistical tests, benthic algal chlorophyll *a* and ash-free dry weight, and diatom metric results, if available (except in the Middle Rockies ecoregion for which there are no validated diatom increaser metrics). The Level II assessment requires both diatom metric results and macroinvertebrate metric results. A Level II assessment is performed only when the Level I assessment conclusions are unclear. When a conclusion for a Level II assessment is unclear, consult management to determine the outcome. An Excel spreadsheet containing the decision matrix is used to arrive at impairment determinations.

Table 6-3 shows the core indicators used for decision-making.

Table 6-3. Nutrients – Mountainous and Transitional Stream Core Indicators

	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level I	Nutrient Concentration (TN, TP)	n ≥ 13 (listed) n ≥ 12 (unlisted) n = 7 (with ≥ 4 exceedances)	Data (mg/L) are evaluated against nutrient criteria using two statistical tests	Ecoregion – Specific Growing Season	≥ 30 days and ≥ 1 stream mile
	Benthic Algal Chlorophyll *a*/Ash-Free Dry Weight	n ≥ 3	Data are evaluated against recommended threshold values = 120 mg Chl *a*/m2 or = 35 g AFDW/m2		
	Diatoms (must be included if data are available)	n ≥ 2 (n = 0 in Middle Rockies ecoregion)	Data are evaluated using an "increaser taxa probability of impairment" Threshold value = 51%		
Level II	Nutrient Concentration (TN, TP)	n ≥ 13 (listed) n ≥ 12 (unlisted) n = 7 (with ≥ 4 exceedances)	Data (mg/L) are evaluated against nutrient criteria using two statistical tests	Ecoregion – Specific Growing Season	≥ 30 days and ≥ 1 stream mile
	Benthic Algal Chlorophyll *a*/Ash-Free Dry Weight	n ≥ 3	Data are evaluated against recommended threshold values = 120 mg Chl *a*/m2 or = 35 g AFDW/m2		
	Diatoms	n ≥ 2 (n = 0 in Middle Rockies ecoregion)	Data are evaluated using an "increaser taxa probability of impairment" Threshold value = 51%		
	Macroinvertebrates	n ≥ 2 (n ≥ 3 in Middle Rockies ecoregion)	Data are evaluated using the Hilsenhoff Biotic Index (HBI) score threshold value = 4		

Statistical Analyses:

Methods	Limits on Decision Errors
Exact Binomial Test	α = 0.25 (25%); β ranges from 0.14-0.35 (14-35%) Critical Exceedance Rate (p) = 0.2 (20%) Effect Size (p2) = 0.15 (15%)
One-Sample Student's T-test for the Mean	α = 0.25 (25%) Critical Exceedance Rate (p) = 0.2 (20%)

Decision Matrix: The Excel spreadsheet "Nutrient Assessment Decision Framework" contains the decision matrix for impairment determinations (see **Appendix B**).

6.3 NUTRIENTS – PRAIRIE STREAMS

Beneficial Uses: Aquatic Life/Fishes & Primary Contact Recreation

Applicability: Wadeable Streams (perennial or intermittent; Strahler Order ≤6)

Level I Core Indicators: Nutrients (TN, TP), Diatoms, Instantaneous Dawn Dissolved Oxygen (DO) Minimum and Afternoon DO Maximum or Long-term DO

Level II Core Indicators: Nutrients (TN, TP), Diatoms, Instantaneous Dawn DO Minimum and Afternoon DO Maximum or Long-term DO, Mean Biological Oxygen Demand (BOD), Visual Field Assessment

Method Overview: Using ecoregion-specific nutrient criteria, a two-level process determines whether beneficial uses are being supported. The Level I assessment considers together the results from two nutrient statistical tests, diatom metric results, and dissolved oxygen delta values (either instantaneous or long term). The Level II assessment incorporates biochemical oxygen demand and visual field assessments (Fish Cover/Other Form). A Level II assessment is performed only when the Level I assessment conclusions are unclear. When a conclusion for a Level II assessment is unclear, consult management to determine the outcome. An Excel spreadsheet containing the decision matrix is used to arrive at impairment determinations.

Table 6-4 shows the core indicators used for decision-making.

Table 6-4. Nutrients – Prairie Stream Core Indicators

	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level I	Nutrient Concentration (TN, TP)	n ≥ 13 (listed) n ≥ 12 (unlisted) n = 7 (with ≥ 4 exceedances)	Data (mg/L) are evaluated against nutrient criteria using two statistical tests	Ecoregion – Specific Growing Season	≥ 30 days and ≥ 1 stream mile
	Diatoms	n ≥ 2	Data are evaluated using an "increaser taxa probability of impairment" Threshold value = 51%		
	Dissolved Oxygen (DO) delta	n ≥ 3	DO delta (i.e., the daily DO maximum minus the daily DO minimum) are evaluated against a concentration threshold value = 5.3 mg/L		

Table 6-4. Nutrients – Prairie Stream Core Indicators

Level	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level II	Nutrient Concentration (TN, TP)	n ≥ 13 (listed) n ≥ 12 (unlisted) n = 7 (with ≥ 4 exceedances)	Data (mg/L) are evaluated against nutrient criteria using two statistical tests	Ecoregion – Specific Growing Season	≥ 30 days and ≥ 1 stream mile
	Diatoms	n ≥ 2	Data are evaluated using an "increaser taxa probability of impairment" Threshold value = 51%		
	Dissolved Oxygen (DO) delta	n ≥ 3	DO delta (i.e., the daily DO maximum minus the daily DO minimum) are evaluated against a concentration threshold value = 5.3 mg/L		
	Biochemical Oxygen Demand (BOD)	n ≥ 3	Data are evaluated against a concentration threshold value = 8 mg/L		
	Visual Field Assessment	n ≥ 2 (during diatom sampling and at least once per site per reach)	Observations of high levels of benthic algae or macrophytes may indicate nitrogen or phosphorus pollution (i.e., excess nutrients)		

Statistical Analyses:

Methods	Limits on Decision Errors
Exact Binomial Test	α = 0.25 (25%); β ranges from 0.14-0.35 (14-35%) Critical Exceedance Rate (p) = 0.2 (20%) Effect Size (p2) = 0.15 (15%)
One-Sample Student's T-test for the Mean	α = 0.25 (25%) Critical Exceedance Rate (p) = 0.2 (20%)

Decision Matrix: The Excel spreadsheet "Nutrient Assessment Decision Framework" contains the decision matrix for impairment determinations (see **Appendix B**).

6.4 SEDIMENT

Beneficial Uses: Aquatic Life/Fishes

Applicability: Western Montana Streams (perennial or intermittent; Strahler Order ≤4) in Northern, Middle, Canadian Rockies, Idaho Batholith Level III Ecoregions

Level I Core Indicators: Riffle Percent Fines (<5.7 mm and <2 mm), Pool Tail Fines (<6 mm), Mean Residual Pool Depth, Pool Frequency, Diatoms, Macroinvertebrates

Level II Core Indicators: Riffle Stability Index (RSI), Subsurface Fines, Intragravel Dissolved Oxygen and Flow, Residual Pool Volume

Method Summary: Using narrative WQS for sediment, a two-level process determines whether beneficial uses are being supported. The Level I assessment includes percent riffle fines (<5.7mm and <2mm), percent pool tail fines (<6mm), residual pool depth, and pool frequency data. When one to three physical parameter values are outside the reference range, biological measures, diatoms and macroinvertebrates, are evaluated. A Level II assessment is performed only when the Level I biology does not indicate impairment and assessment conclusions are unclear.

The Level II assessment incorporates additional data collected for each core indicator; additional parameters are optional. When Level II assessments are unclear, consult management and a local biologist (if feasible) to determine the outcome.

Table 6-5 shows the core indicators used for decision-making.

Table 6-5. Sediment Core Indicators

	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level I	Riffle Fines (< 5.7mm)	n ≥ 1 site (reference) or 3 sites (literature); ≤ 4 riffles; 400 particles	Data are evaluated against a reference dataset or literature/TMDL target values using one of two statistical tests. During Level II assessment, both years' data will be combined unless conditions have changed sufficiently since first year.	Baseflow	Hydrologic water year and ≥ 5 stream miles if homogenous; or 1 per channel type transition if heterogenous
	Riffle Fines (< 2mm)				
	Pool Tail Grid Fines (< 6mm)	n ≥ 1 site (reference) or 3 sites (literature); ≤ 10 scour pool tails; 3 grid tosses per pool tail			
	Mean Residual Pool Depth (RPD)	n ≥ 1 site (reference) or 3 sites (literature); ≤ 20 scour pools			
	Pool Frequency	n ≥ 1 site (reference) or 3 sites (literature)			
	Diatoms	n ≥ 2 (for each metric)	Data are evaluated using a sediment "increaser taxa probability of impairment" metric value	Ecoregion-Specific Growing Season	≥ 30 days and ≥ 1 stream mile
	Macroinvertebrates		Data are evaluated using Observed/Expected (O/E) metric values		

Table 6-5. Sediment Core Indicators

Level	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level II	Riffle Stability Index (RSI) Subsurface Fines Intragravel Dissolved Oxygen and Flow Residual Pool Volume (V^*)	These additional parameters may be (but are not required to be) analyzed during Level II when core indicators do not yield a straightforward sediment impairment determination. When planning the additional data collection, a local biologist and/or hydrologist should be contacted (if feasible) to determine which of these additional parameters should be collected to appropriately address particular issues.			

Statistical Analyses:

Methods	Limits on Decision Errors
One-Sample Wilcoxon Signed Rank Test	α = 0.25 (25%) Tests compare potentially impaired stream data against reference condition data, literature values, or TMDL target values.
Mann-Whitney U Test	

6.5 TEMPERATURE

Beneficial Uses: Aquatic Life/Fishes

Applicability: Wadeable Streams (perennial or intermittent)

Level I Core Indicators: Continuous Temperature

Level II Core Indicators: Continuous Temperature, Model Input Variables

Method Summary: A two-level process may be used to determine whether acute and chronic harm-to-use temperature thresholds are being met for the most sensitive fish species in the level IV ecoregion. The Level I assessment first compares temperature data against fish tolerance thresholds. If thresholds are not exceeded, the waterbody is supporting its beneficial use. If thresholds are exceeded, decisions of impairment are not completed without determining that a significant increase of water temperature is likely caused by human influences.

The Level II assessment is used when the Level I assessment conclusions are unclear (i.e., fish tolerance thresholds are exceeded but the significance of human influence is uncertain). The Level II assessment will use a model to determine the level of significance for human-caused effects to make a decision.

Table 6-6 shows the core indicators used for decision-making.

Table 6-6. Temperature Core Indicators

	Core Indicators	Minimum Sample Size	Analysis of Core Indicators	Index Period	Data Independence
Level I	Continuous Temperature	n ≥ 2 continuous data sets (above and below human influence)	Temperature data are evaluated against fish tolerance thresholds	July 1 – September 15, at a minimum	≤ 30-minute time step and ≥ 1 stream mile
Level II	Continuous Temperature	n ≥ 2 continuous data sets (above and below human influence)	Temperature data are evaluated against fish tolerance thresholds	July 1 – September 15, at a minimum	≤ 30-minute time step and ≥ 1 stream mile
	Model Input Variables (Shading, Hydrology, Channel Geometry, Meteorology)	Minimum sample size for input variables for hydrology, shading, channel geometry, and meteorology are summarized in **Appendix A**	Empirical data are evaluated against reference site data via a model to determine departure from "naturally occurring" condition and significance of human influence	Represent July 1 – September 15 conditions	Data independence for input variables for hydrology, shading, channel geometry, and meteorology are summarized in **Appendix A**

7.0 PRIORITIZING TMDL DEVELOPMENT FOR LISTED WATERS

When a waterbody is placed on the impaired waters list, state and federal law requires a TMDL to be developed. Considerations for prioritizing waterbodies for TMDL development are outlined in (75-5-702(7) MCA). DEQ considers many factors when assessing TMDL priority. Currently, a main factor driving TMDL priority is satisfying the terms of a 2004 settlement agreement and court-ordered planning schedule.

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APPENDIX A – ASSESSMENT METHOD TEMPLATES

Table A-1. Nutrients – Mountainous and Transitional Streams

Pollutant Group	Determining Assessment Reaches
NUTRIENTS - Mountainous & Transitional Streams	The assessor develops the Sampling and Analysis Plan using best professional judgment to define the assessment reach and determine when stratification is warranted (e.g., stratify when one reach of the total segment can be isolated and its condition is substantially different from other parts of the segment).
Beneficial Uses	
Aquatic Life/Fishes (Cold Water) & Primary Contact Recreation	
Applicability	**Overwhelming Evidence of impairment**
Wadeable Montana streams (perennial or intermittent; Strahler Order ≤ 6) in western mountainous and transitional ecoregions	Rigorous data collection is unneccesary if the following are evident: (1) fish kills involving massive growths of senescent algae mats that are attached to the bottom or floating (with DO at dawn likely < 1 mg/L); **or** (2) filamentous algal growth covers the entire bottom from bank to bank and extends continuously for a substantial longitudinal distance (> 150m).
Computations Using Non-Detect Data	
Convert non-detects in the dataset to 50% of reported detection limit; if >> 15% of dataset is non-detect, consult WQPB Standards Section.	

Assessment Method Overview: Using Core Indicators	Very Large Datasets
Method considers together nutrient concentration data and biological core indicator data to determine attainment of ecoregion-specific nutrient criteria using a two-level process. **Level I assessment** considers the results from two nutrient statistical tests, benthic algal chlorophyll *a* (Chl *a*) or ash-free dry weight (AFDW), and diatom metric results (if available). **Level II assessment** requires diatom metric results (except in the Middle Rockies ecoregion for which, at present, there are no validated diatom increaser metrics) *and* macroinvertebrate metric results. Perform Level II assessment only when Level I assessment conclusions are "unclear"; when Level II is "unclear," consult management to determine final outcome. Excel spreadsheet "NtrntAssessFramework.xlsx" contains the decision matrix for attainment determinations.	Assess using nutrient concentrations alone if a very large nutrient dataset exists [n ≥ 90 (listed streams); n ≥ 50 (unlisted streams)]

Statistical Analyses for Nutrient Concentration Data	
Methods	**Limits on Decision Errors**
Exact Binomial Test	α = 0.25 (25%); β = 0.14 - 0.35 (14% - 35%) criticial exceedance rate (p) = 0.2 (20%); effect size (p2) = 0.15 (15%)
One-Sample Student's T-test for the Mean	α = 0.25 (25%); criticial exceedance rate (p) = 0.2 (20%)

	Core Indicators	Analysis of Core Indicators	Index Period	Minimum Sample Size	Data Independence
Level I	Nutrient Concentration (TN, TP)	Data (mg/L) are evaluated against nutrient criteria using two statistical tests. Either Excel spreadsheet "MT-NoncomplianceTool.xls" or "MT-ComplianceTool.xls" is used, depending on listing status.	Ecoregion-Specific Growing Season	n ≥ 13 (listed); n ≥ 12 (unlisted); n = 7 (with ≥ 4 exceedances)	≥ 30 days; ≥ 1 stream mile
	Benthic Algal Chlorophyll *a*/Ash-Free Dry Weight (AFDW)	Data are evaluated against recommended criteria (threshold values: 120 mg Chl *a*/m^2 or 35 g AFDW/m^2).		n ≥ 3	
	Diatoms (must be included if data is available)	Data are evaluated using an "increaser taxa probability of impairment" metric value (threshold value: 51%).		n ≥ 2 (n = 0 in Middle Rockies ecoregion)	
Level II	Nutrient Concentration (TN, TP)	If additional data are collected, re-evaluate using analyses described in Level I prior to incorporating diatoms and macroinvertebrates.	Ecoregion-Specific Growing Season	n ≥ 13 (listed); n ≥ 12 (unlisted); n = 7 (with ≥ 4 exceedances)	≥ 30 days; ≥ 1 stream mile
	Benthic Algae Chlorophyll *a*/Ash-Free Dry Weight (AFDW)			n ≥ 3	
	Diatoms	If additional data are collected, re-evaluate using Level I Analysis described above. Diatoms are required for Level II assessment.		n ≥ 2 (n = 0 in Middle Rockies ecoregion)	
	Macroinvertebrates	Data are evaluated using the Hilsenhoff Biotic Index (HBI) score (threshold value: 4).		n ≥ 2 (n ≥ 3 in Middle Rockies ecoregion)	

Table A-2. Nutrients – Prairie Streams

Pollutant Group	Determining Assessment Reaches
NUTRIENTS - Prairie Streams	The assessor develops the Sampling and Analysis Plan using best professional judgment to define the assessment reach and determine when stratification is warranted (e.g., stratify when one reach of the total segment can be isolated and its condition is substantially different from other parts of the segment).
Beneficial Uses	
Aquatic Life/Fishes (Warm Water) & Primary Contact Recreation	
Applicability	**Overwhelming Evidence of impairment**
Wadeable Montana streams (perennial or intermittent; Strahler Order ≤ 6) in eastern prairie ecoregions	Rigorous data collection is unneccesary if the following are evident: (1) fish kills involving massive growths of senescent algae mats that are attached to the bottom or floating (DO at dawn likely <1 mg/L); **or** (2) filamentous algal growth covers the entire bottom from bank to bank and extends continuously for a substantial longitudinal distance (>150m).
Computations Using Non-Detect Data	
Convert non-detects in the dataset to 50% of reported detection limit; if >> 15% of dataset is non-detect, consult WQPB Standards Section.	

Assessment Method Overview: Using Core Indicators	Very Large Datasets
Method considers together nutrient concentration data and other water chemistry core indicators to determine attainment of ecoregion-specific nutrient criteria using a two-level process. **Level I assessment** considers together the results from two nutrient statistical tests, diatom metric results, and dissolved oxygen delta values (i.e., the daily DO maximum minus the daily DO minimum). **Level II assessment** incorporates biochemical oxygen demand (BOD) and visual field assessments (Fish Cover/Other Form). Perform Level II assessment only when Level I assessment conclusions are "unclear"; when Level II is "unclear," consult management to determine final outcome. Excel spreadsheet "NtrntAssessFramework.xls" contains the decision matrix for attainment determinations.	Assess using nutrient concentrations alone if a very large nutrient dataset exists [n ≥ 90 (listed streams); n ≥ 50 (unlisted streams)]

Statistical Analyses for Nutrient Concentration Data

Methods	Limits on Decision Errors
Exact Binomial Test	α = 0.25 (25%); β = 0.14 - 0.35 (14% - 35%) criticial exceedance rate (p) = 0.2 (20%); effect size (p2) = 0.15 (15%)
One-Sample Student's T-test for the Mean	α = 0.25 (25%); criticial exceedance rate (p) = 0.2 (20%)

	Core Indicators	Analysis of Core Indicators	Index Period	Minimum Sample Size	Data Independence
Level I	Nutrient Concentration (TN, TP)	Data (mg/L) are evaluated against nutrient criteria using two statistical tests. Either Excel spreadsheet "MT-NoncomplianceTool.xls" or "MT-ComplianceTool.xls" is used, depending on listing status.	Ecoregion-Specific Growing Season	n ≥ 13 (listed); n ≥ 12 (unlisted); n = 7 (with ≥ 4 exceed.)	≥ 30 days; ≥ 1 stream mile
	Diatoms	Data are evaluated using an "increaser taxa probability of impairment" metric value (threshold value: 51%)		n ≥ 2	
	Dissolved Oxygen (DO) Deltas	Deltas (i.e., the daily DO maximum minus the daily DO minimum) are evaluated against a concentration threshold (threshold value: 5.3 mg/L)		n ≥ 3	Instantaneous: ≥ 1 day (daily min. pre-dawn to 8:00 am; daily max. usually 2:30 pm - 5:00 pm); Continuous: ≥ 1 day (15-min. time step)

Level II	Nutrient Concentration (TN, TP)	If additional data are collected, re-evaluate using analyses described in Level I prior to incorporating BOD and visual assessment	Ecoregion-Specific Growing Season	n ≥ 13 (listed); n ≥ 12 (unlisted); n = 7 (with ≥ 4 exceed.)	≥ 30 days; ≥ 1 stream mile
	Diatoms			n ≥ 2	
	Dissolved Oxygen (DO) Deltas			n ≥ 3	Instantaneous: ≥ 1 day (daily min. pre-dawn to 8:00 am; daily max. usually 2:30 pm - 5:00 pm); Continuous: ≥ 1 day (15-min. time step)
	Biochemical Oxygen Demand (BOD)	Data are evaluated against a concentration threshold (threshold value: 8 mg/L).		n ≥ 3	Standard 5-day BOD test
	Visual Field Assessments	Observations of high levels of benthic algae or macrophytes may indicate nitrogen or phosphorus pollution (i.e., excess nutrients)		n ≥ 2 (during diatom sampling and at least once per site per reach)	

Table A-3. Metals – Aquatic Life/Fishes (Cold and Warm Water)

<table>
<tr><th>Pollutant Group</th><th colspan="5">Determining Assessment Reaches</th></tr>
<tr><td>METALS</td><td colspan="5" rowspan="2">The assessor develops the Sampling and Analysis Plan using best professional judgment to define the assessment reach and determine when stratification is warranted (e.g., stratify when one reach of the total segment can be isolated and its condition is substantially different from other parts of the segment).</td></tr>
<tr><th>Beneficial Uses</th></tr>
<tr><td>Aquatic Life/Fishes (Cold and Warm Water)</td><td colspan="5"></td></tr>
<tr><th>Applicability</th><th colspan="5">Overwhelming Evidence of impairment</th></tr>
<tr><td>Montana surface waters</td><td colspan="5">Rigorous data collection is unneccesary if either of the following are evident: (1) ≥ 1 sample exceeds twice the acute aquatic life water quality standards (WQS), or (2) ≥ 3 exceedances of aquatic life WQS within an existing sample size of n = 3 to 7.</td></tr>
<tr><th colspan="2">Computations Using Non-Detect Data</th><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">Include non-detects in the dataset if the water quality standard (WQS) is higher than the laboratory detection limit for that metal parameter.</td></tr>
<tr><th colspan="2">Computations Using J-Flagged Data</th><th colspan="4">Very Large Datasets</th></tr>
<tr><td colspan="2">Data are flagged "J" when the empirical data result falls between the Reporting Limit (RL) and the Method Detection Limit (MDL). J flagged data must not be included in the dataset when the associated WQS lies between the RL and the MDL. Include J flagged data when the RL and the MDL are either both above or both below the WQS.</td><td colspan="4">A method for how to select independent samples and deal with larger data sets is being developed and will be addressed at a future date.</td></tr>
<tr><th colspan="2">Assessment Method Overview: Using Core Indicators</th><th colspan="4">Statistical Analyses for Metals Concentration Data</th></tr>
<tr><td colspan="2" rowspan="2">Method considers metals concentration data to determine attainment of water quality standards (WQS) documented in the current Circular
DEQ-7 using a single-level process. <u>Level I assessment</u> evaluates metals concentration data against acute and chronic aquatic life WQS; the total recoverable fraction is considered for all metals except aluminum (which is analyzed for the dissolved fraction). If either of the following conditions are met within the dataset, the waterbody is not attaining WQS for a particular metal: (1) aquatic life WQS exceedance rate > 10%, or (2) ≥ 1 sample exceeds twice the acute aquatic life WQS. If aquatic life exceedance rate is > 10% but no human-caused metals sources are located in the drainage, the assessor should consult management for a case-by-case review.</td><th>Methods</th><th colspan="3">Limits on Decision Errors</th></tr>
<tr><td>Percent exceedance rate</td><td colspan="3">α and β = approximately 0.35 (35%)</td></tr>
<tr><th rowspan="2">Level I</th><th>Core Indicators</th><th>Analysis of Core Indicators</th><th>Index Period</th><th>Minimum Sample Size</th><th>Data Independence</th></tr>
<tr><td>Metals Concentration</td><td>Data (µg/L) are evaluated against both acute and chronic aquatic life WQS using an allowable exceedance rate of 10%</td><td>Year-round (at least 33% of sample set collected during high flow and the remaining collected during baseflow)</td><td>n ≥ 8; or n = 6 with ≥ 3 exceedances, where necessary</td><td>≥ 30 days during baseflow;
temporal independence is evaluated on a case-by-case basis during high flow;
≥ 1 stream mile or > 1 acre</td></tr>
</table>

Table A-4. Metals – Drinking Water

Pollutant Group	Determining Assessment Reaches
METALS	The assessor develops the Sampling and Analysis Plan using best professional judgment to define the assessment reach and determine when stratification is warranted (e.g., stratify when one reach of the total segment can be isolated and its condition is substantially different from other parts of the segment).
Beneficial Uses	
Drinking Water	
Applicability	**Overwhelming Evidence of impairment**
Montana surface waters	Rigorous data collection is unneccesary if the following is evident: ≥ 1 sample exceeds the human health standard.

Computations Using Non-Detect Data	
Include non-detects in the dataset if the water quality standards (WQS) is higher than the laboratory detection limit for that metal parameter.	
Computations Using J-Flagged Data	**Very Large Datasets**
Data are flagged "J" when the empirical data result falls between the Reporting Limit (RL) and the Method Detection Limit (MDL). J flagged data must not be included in the dataset when the associated WQS lies *between* the RL and the MDL. Include J flagged data when the RL and the MDL are either both above or both below the WQS.	A method for how to select independent samples and deal with larger data sets is being developed and will be addressed at a future date.

Assessment Method Overview: Using Core Indicators	Statistical Analyses for Metals Concentration Data	
	Methods	**Limits on Decision Errors**
Method considers metals concentration data to determine attainment of water quality standards (WQS) documented in the current Circular DEQ-7 using a single-level process. **Level I assessment** evaluates metals concentration data against human health WQS; the total recoverable fraction is considered for all metals except aluminum (which is analyzed for the dissolved fraction). If the following condition is met within the dataset, the waterbody is not attaining WQS for a particular metal: ≥ 1 sample exceeds the human health WQS. If human health exceedances exist but no human-caused metals sources are located in the drainage, the assessor should consult management for a case-by-case review.	Percent exceedance rate	n/a

	Core Indicators	Analysis of Core Indicators	Index Period	Minimum Sample Size	Data Independence
Level I	Metals Concentration	Data (µg/L) are evaluated against human health WQS using an allowable exceedance rate of 0%	Year-round (at least 33% of sample set collected during high flow and the remaining collected during baseflow)	n ≥ 8; **or** n ≥ 1 with ≥ 1 exceedances, where necessary	≥ 30 days during baseflow; temporal independence is evaluated on a case-by-case basis during high flow; ≥ 1 stream mile or > 1 acre

Table A-5. Sedimentation/Siltation and Bedload Solids

Pollutant Group	Determining Assessment Reaches
SEDIMENT (Sedimentation/Siltation and Bedload Solids)	Physical data must be collected from a minimum of 1 representative site per stream segment. If the segment is homogenous, 1 site must be sampled per 5 miles. The assessor will use best professional judgment to determine whether data from multiple sites may be combined; the combined reaches must be relatively homogenous (i.e., no transition between two channel types). The site length considered sufficient to effectively describe habitats can vary depending on the heterogeneity of the stream, but must be ≥ 20 times the bankfull width.
Beneficial Uses	**Overwhelming Evidence of impairment**
Aquatic Life/Fishes (Cold Water)	Rigorous data collection is unneccesary if both of the following criteria are met: (1) known sources of sediment have been identified and documented, and, (2) for the stream segment being assessed, the average value for a parameter is equal to or greater than the maximum value plus the median value for the same parameter from the applicable reference dataset. Only percent fine core indicators (derived from pebble count and grid toss) will be used in overwhelming evidence-based decisions.
Applicability	
Western Montana streams (perennial or intermittent) that are: (1) Strahler Order ≤ 4 (order 1 only when appropriate), (2) perennial or intermittent, and (3) contained within the Northern, Middle, and Canadian Rockies or Idaho Batholith level III ecoregions.	
Computations Using Non-Detect Data	
n/a	

Assessment Method Overview: Using Core Indicators	Statistical Analyses for Sediment Data	
	Methods	**Limits on Decision Errors**
Method considers together physical and biological core indicator data to determine attainment of water quality standards for sediment using a two-level process. **Level 1 assessment** includes percent riffle fines (<5.7mm and <2mm), percent pool tail fines (< 6mm), residual pool depth (RPD), and pool frequency data. To assess, when one or more physical parameter values is outside reference range, evaluate biological measures. If all physical parameters are within the acceptable range of reference, then the waterbody will be considered "not impaired". When four or more parameters are outside of the acceptable range of reference, the waterbody is considered "impaired". If one to three of the parameters are not within the acceptable range of reference, biology will be evaluated. If ≥ 25% of all biological metrics suggest biological limitation, then the waterbody is considered "impaired." If the biology indicates non-impairment in this situation, a Level II assessment occurs. **Level II assessment** incorporates data collected during a second monitoring season for each core indicator and/or additional parameters to make a decision. Consult management and a local biologist (if feasible) to determine final outcome when Level II assessments are "unclear".	1-Sample Wilcoxon Signed Rank Test	α = 0.25 (25%) Tests compare potentially impaired stream data against reference condition data, literature values, or TMDL target values.
	Mann-Whitney U test	

	Core Indicators	Analysis of Core Indicators	Index Period	Minimum Sample Size	Data Independence
Level I and **Level II**	Riffle Fines (< 5.7mm)	Data are evaluated against a reference dataset or literature/TMDL target values using one of two statistical tests. During Level II assessment, both years' data will be combined unless conditions have changed sufficiently since first year.	Baseflow	n ≥ 1 site (reference) or 3 sites (literature); ≤ 4 riffles; 400 particles	hydrologic water year; ≥ 1 site per 5 stream miles if segment is homogenous or ≥ 1 site per channel type transition if heterogenous
	Riffle Fines (< 2mm)				
	Pool Tail Grid Fines (< 6mm)			n ≥ 1 site (reference) or 3 sites (literature); ≤ 10 scour pool tails; 3 grid tosses per pool tail	
	Mean Residual Pool Depth (RPD)			n ≥ 1 site (reference) or 3 sites (literature); ≤ 20 scour pools	
	Pool Frequency			n ≥ 1 site (reference) or 3 sites (literature)	
	Diatoms	Data are evaluated using a sediment "increaser taxa probability of impairment" metric value	Ecoregion-Specific Growing Season	n ≥ 2 (for each metric)	≥ 30 days; ≥ 1 stream mile
	Macroinvertebrates	Data are evaluated using Observed/Expected (O/E) metric values			
Level II	Riffle Stability Index (RSI)	These additional parameters may be (but are not required to be) collected only during Level II when core indicators do not yield a straightforward sediment impairment determination. When planning the second year of data collection, a local biologist and/or hydrologist should be contacted (if feasible), to determine which of these additional parameters should be collected to appropriately address particular issues.			
	Subsurface Fines				
	Intragravel Dissolved Oxygen and Flow				
	Residual Pool Volume (V*)				

Table A-6. Temperature

Pollutant Group	Determining Assessment Reaches
TEMPERATURE	The assessor develops the Sampling and Analysis Plan using best professional judgment and desktop tools to define assessment reaches and determine where reach breaks are warranted (e.g., stratify when conditions of riparian shading, irrigation diversion, or channel morphology of one assessment reach can be isolated from other assessment reaches). A segment must be ≤ 40 miles with ≤ 5 reaches.
Beneficial Uses	
Aquatic Life/Fishes (Cold and Warm Water)	
Applicability	
Wadeable (perennial or intermittent; Strahler Order ≤ 6) Montana streams	

Assessment Method Overview: Using Core Indicators	
Method considers continuous temperature data to determine attainment of acute and chronic harm-to-use temperature thresholds for the most sensitive fish species in the level IV ecoregion containing the waterbody segment. **Level I assessment** first compares temperature data against fish tolerance thresholds. If thresholds are not exceeded, the waterbody is attaining its beneficial use. If thresholds are exceeded, decisions of impairment are not completed without determining that a significant increase of water temperature is likely caused by human influences. **Level II assessment** employs a model if the level of significance for human-caused impacts is unclear, and further information must be collected to populate the model. Perform Level II assessment only when Level I assessment conclusions cannot differentiate natural condition from multiple suspected human impacts on a waterbody segment.	A model may be used to evaluate field data ("existing condition") against reference site data ("reference condition") for facilitating interpretation of potential human caused sources relative to departure from "naturally occurring" conditions. Use of a model is not necessary if empirical evidence is sufficient to make a use support determination (i.e., exceedances of fish tolerance thresholds and clear evidence of human caused sources).

	Core Indicators	Analysis of Core Indicators	Index Period	Minimum Sample Size	Data Independence
Level I	Continuous Temperature Data	Data are evaluated against fish tolerance thresholds.	July 1 - Sept 15, at a minimum	n ≥ 2 continuous data sets (above and below human influence)	≤ 30 minute time step; ≥ 1 stream mile or identification of independent source
Level II	Continuous Temperature Data	If additional data are collected, re-evaluate using analyses described in Level I assessment	July 1 - Sept 15, at a minimum	n ≥ 2 continuous data sets (above and below human influence)	≤ 30 minute time step; ≥ 1 stream mile or identification of independent source
	Hydrology Variables (segment inflow, segment outflow, inflow temperature)	These are input variables for the model. Empirical data are evaluated against reference site data via the model to determine departure from "naturally occurring" condition and significance of human influence.	Baseflow	n ≥ 1 per site	≥ 1 stream mile or identification of significant source
	Shading Variables (riparian shade producing vegetation offset, height, and crown width)		Represent July 1 - Sept 15 conditions	n ≥ 3 transects per site	≥ 150 meters or 40 wetted widths between transects
	Channel Geometry Variables (segment length, upstream and downstream elevation, wetted width and depth, Manning's n)			n ≥ 2 per segment	≥ 1 stream mile
	Meteorology Variables (segment latitude, average daily air temperature, relative humidity, wind speed, ground temperature, thermal gradient, % possible sun, time of year)			n ≥ 1 per modeling effort	

APPENDIX B – DECISION MATRICES FOR NUTRIENTS

Table B-1. Nutrients – Mountain And Transitional Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment (OPTIONAL)*	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:
1	PASS	PASS	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	≤51%	Waterbody is not nutrient impaired. All indications show that the stream is in compliance.	No	
2	PASS	PASS	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	>51%	Waterbody is not nutrient impaired. Most indications show that the stream is in compliance. If diatom metric used, may be giving a false positive.	No	
3	PASS	FAIL	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	≤51%	Waterbody might be nutrient impaired. If diatom metric and benthic Chl*a* data were both used, waterbody is not nutrient impaired. Suggests pulsed nutrient loads occur but magnitude and durations is not sufficient to manifest problems in stream, as shown by in-compliance Chla and diatom metric. If diatom data not used, impairment unclear, so carry out level II assessment.	Maybe. Do level II assessment if required, which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab
4	PASS	FAIL	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	>51%	Waterbody might be nutrient impaired. If diatom metric and benthic Chl*a* data were both used, waterbody is nutrient impaired. Suggests pulsed nutrient loads occur but may have missed peak benthic algae biomass, but diatoms indicate there is a nutrient problem. If diatom data not used, impairment unclear, so carry out level II assessment.	Maybe. Do level II assessment if required, which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab

Table B-1. Nutrients – Mountain And Transitional Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment (OPTIONAL)*	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:
5	FAIL	PASS	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	≤51%	Waterbody might be nutrient impaired. If diatom metric and benthic Chl*a* data were both used, waterbody is not nutrient impaired. Nutrient concentrations are in excess of the allowable exceedance rate, but there is no indication of concentrations greatly elevated above the criteria (i.e., passed t-test). No excess algal growth, and increaser taxa impairment-probability is below threshold. If only benthic Chl a data were used (no diatom data), unclear; do a level II assessment.	Maybe. Do level II assessment if required, which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab
6	FAIL	PASS	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	>51%	Waterbody might be nutrient impaired. If diatom metric and benthic Chla were both used, waterbody is nutrient impaired. Diatom metric confirms results of the nutrient concencentration data (failed binomial, thus elevated nutrients). Timing may have missed peak Chla biomass. If only benthic Chla were used (no diatom data), do a level II assessment.	Maybe. Do level II assessment if required, which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab
7	FAIL	FAIL	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	≤51%	Unclear — Nutrient concentrations are in excess of the exceedance rate and there is indication of concentrations much in excess of the criteria (failed t-test). Likely that waterbody sometimes has excess benthic algae biomass, algae sampling timing may have missed peaks. Do a level II assessment to complete decision. Further algae and nutrient sampling is justified.	Yes. Do level II assessment which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab

Table B-1. Nutrients – Mountain And Transitional Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment (OPTIONAL)*	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:
8	FAIL	FAIL	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/m^2	>51%	Waterbody might be nutrient impaired. If diatom metric and benthic Chla were both used, waterbody is nutrient impaired. Both assessments of nutrient concentrations indicate elevated concentrations, and the diatom increaser taxa metric shows high probability of impairment. Timing of benthic algae sampling may have missed peaks. If only Chla data was used, unclear; do a level II assessment.	Maybe. Do level II assessment if required, which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab
9	PASS	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	≤51%	Unclear — Algae might be taking up nutrients and leading to lower instream nutrient concentrations with concurrent high benthic algae biomass; however, diatom metric (if available) contradicts Chla data. Normally in this scenario TP and/or TN would be expected to exceed criteria. Do a level II assessment to complete decision.	Yes. Do level II assessment which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab
10	PASS	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	>51%	Unclear — Algae may be taking up nutrients and leading to low instream nutrient concentrations with concurrent high benthic algae biomass; diatom metric (if available) supports this idea. Normally in this scenario TP and/or TN would be expected to exceed their criteria. Do a level II assessment to complete decision.	Yes. Do level II assessment which includes macroinvertebrates and diatom samples	Go to "Mountains&transitional 2" tab

Table B-1. Nutrients – Mountain And Transitional Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment (OPTIONAL)*	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:
11	PASS	FAIL	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	≤51%	Waterbody is nutrient impaired. Non-compliance with the T-test suggests that pulsed nutrient loads are allowing high algae biomass to be maintained via luxury uptake. Diatoms may be giving a false negative.	No	
12	PASS	FAIL	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	>51%	Waterbody is nutrient impaired. Non-compliance with the T-test suggests that pulsed nutrient loads are allowing high algae biomass to be maintained via luxury uptake. Diatoms confirm enrichment finding.	No	
13	FAIL	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	≤51%	Waterbody is nutrient impaired. Suggests sustained nutrient values above the standard but not necessarily pulsed nutrient loading. Diatoms may be giving a false negative.	No	
14	FAIL	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	>51%	Waterbody is nutrient impaired. Suggests sustained nutrient values above the standard but not necessarily pulsed nutrient loading.	No	
15	FAIL	FAIL	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	≤51%	Waterbody is nutrient impaired. Most indicators show that the stream is not in compliance. Diatoms could be giving a false negative.	No	
16	FAIL	FAIL	>120 mg Chl*a*/m^2 or >35 g AFDW/m^2	>51%	Waterbody is nutrient impaired. All indicators show that the stream is not in compliance.	No	
* However, if the data minima are available for this data category, they must be used in the decision framework. No diatom increaser taxa metrics are available for the Middle Rockies.							

Table B-2. Nutrients – Mountain and Transitional Level 2 Decision Matrix

READ FIRST: You should be on this sheet due to an "unclear" result from the level I assessment. If you have collected new data as part of your level II work, you should take your entire dataset and first go back to the "Mountain & transitional 1" tab to see if you can now come to an unambiguous conclusion there. If you get an "unclear" result again, return here and follow the decision rules on this tab.

Scenario(s)	Scenario subclass	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment	Macroinvertebrate HBI Score	Resulting Decision	Other Considerations
5,6	5/6a	FAIL	PASS	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/ m^2	n/a	>4	Waterbody <u>is</u> nutrient impaired. Nutrients are elevated, according to Binomial, and HBI score suggests nutrients are the cause. Sampling timing may have missed algal peak .	This scenario will apply in the Middle Rockies where there is no diatom increaser metrics available
5,6	5/6b	FAIL	PASS	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/ m^2	n/a	≤4	Waterbody <u>is not</u> nutrient impaired. Nutrients are elevated, according to Binomial, but acceptable algal growth and acceptable HBI score suggests nutrients are not causing a serious problem. Stream may have characteristics that prevent somewhat elevated nutrients from impacting uses (high shade, for example).	This scenario will apply in the Middle Rockies where there is no diatom increaser metrics available
7,8	7/8a	FAIL	FAIL	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/ m^2	≤51%	>4	Waterbody <u>is</u> nutrient impaired. Nutrients are elevated, and HBI score suggests nutrients are the cause. Sampling timing may have missed algal peak; cuase of acceptable diatom metric result not clear (possible false negative, or close the decision threshold?).	

Table B-2. Nutrients – Mountain and Transitional Level 2 Decision Matrix

READ FIRST: You should be on this sheet due to an "unclear" result from the level I assessment. If you have collected new data as part of your level II work, you should take your entire dataset and first go back to the "Mountain & transitional 1" tab to see if you can now come to an unambiguous conclusion there. If you get an "unclear" result again, return here and follow the decision rules on this tab.

Scenario(s)	Scenario subclass	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment	Macroinvertebrate HBI Score	Resulting Decision	Other Considerations
7,8	7/8b	FAIL	FAIL	≤120 mg Chl*a*/m^2 or ≤35 g AFDW/ m^2	≤51%	≤4	Borderline still. **Consult management and discuss process to determine final outcome.**	Is the macroinvertebrate O/E score > 1.0? Suggest increased macroinvertebrate diversity resulting from increased primary productivity.
9	9a	PASS	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/ m^2	≤51%	>4	Waterbody is nutrient impaired. Algae may be taking up nutrients and leading to low instream nutrient concentrations with concurrent high benthic algae biomass. Eutrophication is supported by high HBI score. Diatoms may be giving a false negative or may be near the decision threshold.	
9	9b	PASS	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/ m^2	≤51%	≤4	Mixed signals; nutrient concentration acceptable, diatom metric and HBI show no problems, but high benthic algal biomass. **Consult management and discuss process to determine final outcome.**	Is the macroinvertebrate O/E score > 1.0? Suggest increased macroinvertebrate diversity resulting from increased primary productivity.

Table B-2. Nutrients – Mountain and Transitional Level 2 Decision Matrix

READ FIRST: You should be on this sheet due to an "unclear" result from the level I assessment. If you have collected new data as part of your level II work, you should take your entire dataset and first go back to the "Mountain & transitional 1" tab to see if you can now come to an unambiguous conclusion there. If you get an "unclear" result again, return here and follow the decision rules on this tab.

Scenario(s)	Scenario subclass	Nutrient Binomial Test	Nutrient T-test	Benthic Algae	Diatom Increaser Taxa-Probability of Impairment	Macroinvertebrate HBI Score	Resulting Decision	Other Considerations
10	10a	PASS	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/ m^2	>51%	>4	Waterbody <u>is</u> nutrient impaired. Algae may be taking up nutrients and leading to low instream nutrient concentrations with concurrent high benthic algae biomass. Diatoms and HBI score suggests nutrients are the cause.	
10	10b	PASS	PASS	>120 mg Chl*a*/m^2 or >35 g AFDW/ m^2	>51%	≤4	Mixed signals; nutrient concentration acceptable, diatom metric and HBI show contradictory results, and there is elevated benthic algal biomass. **Consult management and discuss process to determine final outcome.**	Is the macroinvertebrate O/E score > 1.0? Suggest increased macroinvertebrate diversity resulting from increased primary productivity.

Table B-3. Nutrients – Plains Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	DO delta	Plains Region Diatom Increaser Taxa-Probability of Impairment	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:	Notes
1	PASS	PASS	≤ 5.3 mg/L	≤51%	Waterbody is not nutrient impaired. All indications show that the stream is in compliance.	No		
2	PASS	PASS	≤ 5.3 mg/L	>51%	Unclear — Algae & plants might be taking up nutrients and leading to lower instream nutrient concentrations concurrent with high algae and plant biomass; however, diatom metric contradicts DO delta results. Normally in this scenario TP and/or TN would be expected to exceed criteria. Do a level II assessment to complete decision.	Yes. Do level II assessment. For this scenario this means a required 2nd summer of data collection. Collect BOD data.		
3	PASS	FAIL	≤ 5.3 mg/L	≤51%	Waterbody is not nutrient impaired. Suggests pulsed nutrient loads occur but magnitude and durations is not sufficient to manifest problems in stream, as shown by compliance with DO delta and diatom metric.	No		
4	PASS	FAIL	≤ 5.3 mg/L	>51%	Waterbody is nutrient impaired. Suggests pulsed nutrient loads occur but DO delta may have given false negative; diatoms however indicate there is a nutrient problem.	No		

Table B-3. Nutrients – Plains Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	DO delta	Plains Region Diatom Increaser Taxa-Probability of Impairment	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:	Notes
5	FAIL	PASS	≤ 5.3 mg/L	≤51%	Unclear—Nutrient concentrations are in excess of the allowable exceedance rate, but there is no indication of concentrations greatly elevated above the criteria (i.e., passed t-test). No exceedance of DO delta, and diatom increaser taxa in compliance. Inherently high false-negative rates of the response variables could be leading to their outcomes. Do a level II assessment to complete decision.	Yes. Do level II assessment. For this scenario this means a required 2nd summer of data collection. **SEE NOTES TO RIGHT.**		If you suspect problem may be manifested via very high phytoplankton concentrations, collect phytoplankton Chla as well.
6	FAIL	PASS	≤ 5.3 mg/L	>51%	Waterbody is nutrient impaired. Diatom metric confirms results of the nutrient concencentration data (failed binomial, thus elevated nutrients). False negative likely for the DO delta result.	No		
7	FAIL	FAIL	≤ 5.3 mg/L	≤51%	Unclear — Nutrient concentrations are in excess of the exceedance rate and there is indication of concentrations much in excess of the criteria (failed t-test). Inherent high false negative rates of both the diatom metric and DO delta may be why they do not indicate a problem. Do a level II assessment to complete decision. Further nutrient, DO delta, and diatom data sampling is justified.	Yes. Do level II assessment. For this scenario this means a required 2nd summer of data collection. **SEE NOTES TO RIGHT.**	Go to "Plains 2" tab	If you suspect problem may be manifested via very high phytoplankton concentrations, collect phytoplankton Chla as well.

Table B-3. Nutrients – Plains Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	DO delta	Plains Region Diatom Increaser Taxa-Probability of Impairment	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:	Notes
8	FAIL	FAIL	≤ 5.3 mg/L	>51%	Waterbody is nutrient impaired. Both assessments of nutrient concentrations indicate elevated concentrations, and the diatom increaser taxa metric shows a nutrient impact. DO delta measurements may have missed high values (i.e., false negative).	No		
9	PASS	PASS	> 5.3 mg/L	≤51%	Unclear — Algae & plants might be taking up nutrients and leading to lower instream nutrient concentrations concurrent with high algae and plant biomass; however, diatom metric contradicts DO delta results. Normally in this scenario TP and/or TN would be expected to exceed criteria. Do a level II assessment to complete decision.	Yes. Do level II assessment. For this scenario this means a required 2nd summer of data collection. Collect BOD data. **SEE NOTES TO RIGHT.**	Go to "Plains 2" tab	If you suspect problem may be manifested via very high phytoplankton concentrations, collect phytoplankton Chla as well.
10	PASS	PASS	> 5.3 mg/L	>51%	Unclear — Algae may be taking up nutrients and leading to low instream nutrient concentrations with concurrent high algae and plant biomass; diatom metric supports this idea as do the DO delta results. Normally in this scenario TP and/or TN would be expected to exceed their criteria. Do a level II assessment to complete decision.	Yes. Do level II assessment. For this scenario this means a required 2nd summer of data collection. Collect BOD data. **SEE NOTES TO RIGHT.**	Go to "Plains 2" tab	If you suspect problem may be manifested via very high phytoplankton concentrations, collect phytoplankton Chla as well.

Table B-3. Nutrients – Plains Level 1 Decision Matrix

Scenario	Nutrient Binomial Test	Nutrient T-test	DO delta	Plains Region Diatom Increaser Taxa-Probability of Impairment	Resulting Decision	Further Sampling?	If you have collected the data for, or have the data for, a level II assessment:	Notes
11	PASS	FAIL	> 5.3 mg/L	≤51%	Waterbody is nutrient impaired. Non-compliance with the T-test suggests that pulsed nutrient loads are allowing high algae and plant biomass to be maintained, Diatoms may be giving a false negative.	No		
12	PASS	FAIL	> 5.3 mg/L	>51%	Waterbody is nutrient impaired. Non-compliance with the T-test suggests that pulsed nutrient loads are allowing high algae and plant biomass to be maintained, Diatoms confirm enrichment finding.	No		
13	FAIL	PASS	> 5.3 mg/L	≤51%	Waterbody is nutrient impaired. Suggests sustained nutrient values above the standard but not necessarily pulsed nutrient loading. Diatom metrics may be giving a false negative.	No		
14	FAIL	PASS	> 5.3 mg/L	>51%	Waterbody is nutrient impaired. Suggests sustained nutrient values above the standard but not necessarily pulsed nutrient loading.	No		
15	FAIL	FAIL	> 5.3 mg/L	≤51%	Waterbody is nutrient impaired. Most indicators show that the stream is not in compliance. Diatoms probably giving a false negative.	No		
16	FAIL	FAIL	> 5.3 mg/L	>51%	Waterbody is nutrient impaired. All indicators show that the stream is not in compliance.	No		

Table B-4. Nutrients – Plains Level 2 Decision Matrix

READ FIRST: You should be on this sheet due to an "unclear" result from the level I assessment. If you have collected new data as part of your level II work, you should take your e unambiguous conclusion there. If you get an "unclear" result again, return here and follow the decision rules on this tab.

Scenario	Scenario Subclass	Nutrient Binomial Test	Nutrient T-test	DO delta	Plains Region Diatom Increaser Taxa-Probability of Impairment	BOD	Resulting Decision
2	2a	PASS	PASS	≤ 5.3 mg/L	>51%	> 8.0 mg/L	Waterbody may be nutrient impaired, **BUT SEE NOTE TO RIGHT TO MAKE FINAL CA** Possible BOD problem; if DEQ-7 DO standards (1-Day Minimum; use your dawn DO measurements) have not been exceeded, do not list for BOD. If they have, do list for Consult with your manager on BOD listing details.
2	2b	PASS	PASS	≤ 5.3 mg/L	>51%	≤ 8.0 mg/L	Waterbody may be nutrient impaired. (1) If the assessment reach meets the conditio Notes box to right, waterbody is nutrient impaired. (2) If waterbody does not meet t conditions in the Notes box to right, waterbody is not nutrient impaired.
5	n/a	FAIL	PASS	≤ 5.3 mg/L	≤51%	n/a	(1) If visual assessment methods (Fish Cover/Other form) indicate very high levels of and/or macrophytes, or phytoplankton density is very high, waterbody is nutrient im Consistant failure of the binomial indicates elevated nutrients. The inherently high fa negative rates of the diatom metrics and DO delta may have prevented those param from indicating a problem. (2) If visual assessment does not show very high levels of and/or macrophytes, nor are phytoplankton densities high, borderline still. **For (2), c management and discuss process to determine final outcome.**
7	n/a	FAIL	FAIL	≤ 5.3 mg/L	≤51%	n/a	(1) If visual assessment methods (Fish Cover/Other form) indicate very high levels of and/or macrophytes, or very high phytoplankton density, waterbody is nutrient imp The inherently high false-negative rates of the diatom metrics and DO delta have like prevented those parameters from indicating a problem. (2) If visual assessment does show high levels of algae and/or plants, and phytoplankton densities are not high, b still. **For (2), consult management and discuss process to determine final outcome.**
9	9a	PASS	PASS	> 5.3 mg/L	≤51%	> 8.0 mg/L	Waterbody is not nutrient impaired. Problem is likely related to BOD, which is an org enrichment problem. Waterbody should be listed for BOD; consult with your manag BOD listing details.

Table B-4. Nutrients – Plains Level 2 Decision Matrix

READ FIRST: You should be on this sheet due to an "unclear" result from the level I assessment. If you have collected new data as part of your level II work, you should take your e
unambiguous conclusion there. If you get an "unclear" result again, return here and follow the decision rules on this tab.

Scenario	Scenario Subclass	Nutrient Binomial Test	Nutrient T-test	DO delta	Plains Region Diatom Increaser Taxa-Probability of Impairment	BOD	Resulting Decision
9	9b	PASS	PASS	> 5.3 mg/L	≤51%	≤ 8.0 mg/L	(1) If visual assessment methods (Fish Cover/Other form) indicate very high levels of and/or macrophytes, especially if Coontail (*Ceratophyllum* spp.) dominates, or altern waterbody has very high phytoplankton density, waterbody is nutrient impaired. Alg and/or macrophytes are probably taking up the nutrients. (2) If visual assessment d show excessive high levels of algae and/or plants, and phytoplankton density is not h waterbody is probably not nutrient impaired. **SEE NOTE AT RIGHT TO MAKE FINAL C**
10	10a	PASS	PASS	> 5.3 mg/L	>51%	> 8.0 mg/L	(1) If visual assessment methods (Fish Cover/Other form) indicate high levels of alga macrophytes, or alternatively, waterbody has very high phytoplankton density, wate nutrient impaired. Algae and/or macrophytes are probably taking up the nutrients. F is also related to BOD, and should be listed for BOD as well. (2) If visual assessment m (Fish Cover/Other form) does not indicate high levels of algae and/or macrophytes, m there high phytoplankton density, waterbody should be listed for BOD. **For (2), cons your manager on final nutrient listing decision.**
10	10b	PASS	PASS	> 5.3 mg/L	>51%	≤ 8.0 mg/L	(1) If visual assessment methods (Fish Cover/Other form) indicate high levels of alga macrophytes, or alternatively, waterbody has very high phytoplankton density, wate nutrient impaired. Algae and/or macrophytes are probably taking up the nutrients. visual assessment does not show high levels of algae and/or plants, nor is there high phytoplankton density, borderline still. **For (2), consult management and discuss pr determine final outcome.**